Chapter 42
Improving Supply Chain Delivery Performance Using Lean Six Sigma

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ABSTRACT

Models for evaluating and improving delivery performance play an important role in the management of supply chains. A review of supply chain delivery models that use Six Sigma methodologies indicate that the models are limited to only make-to-order supply chains where improvement in delivery performance occurs at a fixed (static) point in time. In this chapter, the authors present a generalized delivery performance model that overcomes these limitations. The model presented here can be used to measure delivery performance in both make-to-order and make-to-stock supply chains and supports improvement in delivery performance over a planned time horizon with definable milestones for attaining targeted levels of improvement. Numerical illustrations of the model are presented.

INTRODUCTION

In reaction to today's globally competitive business environment, organizations face challenges to improve customer service while simultaneously reducing costs and shortening product lifecycles. In response to these challenges many organizations have adopted the supply chain management (SCM) philosophy. Under the SCM philosophy, processes such as production planning and inventory control, sourcing, vendor relations and customer relationship management are viewed as value adding activities requiring coordination and integration among functional areas that are both internal and external to the organization.

DOI: 10.4018/978-1-5225-1837-2.ch042

The positive impact of the SCM philosophy on firm performance has been empirically established in the literature (Beheshti, Oghazi, Mostaghel, & Hultman, 2014; Leuschner, Rogers, & Charvet, 2013; Huo, 2012; Wagner, Grosse-Ruyken, & Erhun, 2012; Shi & Yu, 2012; Johnson & Templar, 2011; Kim, 2009).

As discussed in Ramaa, Subramanya, and Rangaswamy (2013), Martin and Patterson (2009), Shepherd and Günter (2006) and Gunasekaran, Patel, and McGaughey (2004), performance measurement plays an integral role in the SCM philosophy. Performance measurements assist managers in meeting short term day-to-day objectives as well as long term strategic goals. For effective performance measurement, formal quantitative models for performance measurement are needed that are capable of incorporating a wide range of factors (Suwignjo, Bititci, & Carrie 2000; Bititci, Suwignjo, & Carrie, 2001). Frameworks for supply chain performance evaluation may be found in Cuthbertson and Piotrowicz (2011), Azevedo, Carvalho, and Cruz-Machado (2011) and Chan, Chan, and Qi (2006) while specific metrics for use in measuring supply chain performance are found in Gopal and Thakkar (2012), Sambasivan, Mohamed, and Nanden (2009) and Gunasekaran and Kobe (2007).

In this chapter we concentrate on one aspect of overall supply chain performance, delivery timeliness to the final customer. As summarized in Bushuev and Guiffrida (2012), the delivery process within a supply chain is of critical concern to supply chain managers since delivery performance directly impacts customer satisfaction levels. This assessment of the importance of measuring delivery performance in supply chains is in agreement with recent research by Chapman, Beron, and Haggett (2011), Rao, Rao, and Muniswamy (2011), Forslund, Jonsson, and Mattsson (2009), Lockamy and McCormack (2004) and Vachon and Klassen (2002). As a time-based measure, delivery performance within supply chains is typically evaluated with respect to a customer defined delivery window (Safaei, Issa, Seifert, Thoben, & Lang, 2013; Guiffrida & Nagi, 2006). The customer defines benchmarks in time to which delivery times are compared by using a delivery window. Based on the delivery window, a delivery is classified as being early, on-time or late. For a compilation of actual delivery windows used in industrial supply chains the reader is referred to Guiffrida (2014).

Quantitative models for measuring and improving supply chain delivery performance that utilize delivery windows have appeared in the literature and Guiffrida, Chen, Liang, Ngniatedema, and Tanai (2013) provide a comprehensive review of this literature. Supply chain delivery window models can be broadly classified into the following two categories: cost-based models and index-based models. Cost-based models use loss functions to translate the probability of untimely (early and late) deliveries into an expected cost measure. Index-based models utilize Six Sigma statistical tools such as process capability indices, tolerancing and control charts to provide cost based metrics for evaluating delivery performance. In both classes of models costs are incurred when deliveries are untimely (early or late) and for investments dedicated to improving delivery performance. Continuous improvement in delivery performance is captured within the modeling frameworks of both cost-based and index-based supply chain delivery models through the reduction of variability in the delivery time distribution. Reducing the variance of the delivery time distribution for a stated delivery window and fixed mean delivery time reduces the probability of early and late deliveries (which are considered to be delivery process defects) while increasing the probability of on-time deliveries.

The importance of Six Sigma in improving supply chain operations has received considerable attention in the literature (see for example Tetteh, Eyob, & Amewokunu, 2013; Salah, Rahim, & Carretero, 2011; Nabhani & Shokri, 2009; Yang, Choi, Park, Suh, & Chae, 2007; Knowles, Whicher, Femat, & Canales, 2005). Index-based delivery performance models are attractive for Six Sigma initiatives to improve supply chain delivery performance since the foundation of these models, which is based on